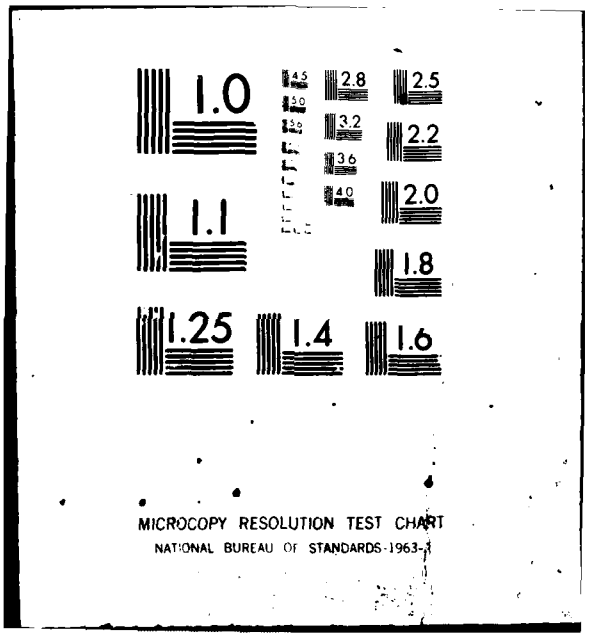
AD-A085 452 DEFENSE MAPPING AGENCY HYDROGRAPHIC/ TOPOGRAPHIC CENT--ETC F/G 17/7
A CALCULATOR PROGRAM FOR MIXING MERCATOR AND GREAT CIRCLE SAILI--ETC(U)
SEP 80 J G ULRICH

UNCLASSIFIED NL

END
DATE FILMED
7-80
DTIC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: First International Symposium on Ship Operations, New York, NY
2. GOVT ACCESSION NO.: AD-A085 452
3. RECIPIENT'S CATALOG NUMBER:

4. TITLE (and Subtitle): A Calculator Program for Mixing Mercator and Great Circle Sailings
5. TYPE OF REPORT & PERIOD COVERED: N/A
6. PERFORMING ORG. REPORT NUMBER: N/A

7. AUTHOR(s): John G. Ulrich
8. CONTRACT OR GRANT NUMBER(s): N/A

9. PERFORMING ORGANIZATION NAME AND ADDRESS: Defense Mapping Agency Hydrographic/Topographic Center, Washington, D.C. 20315
10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: N/A

11. CONTROLLING OFFICE NAME AND ADDRESS: DMA Hydrographic/Topographic Center, ATTN: PPTD (Tech. Pubs.), Washington, D.C. 20315
12. REPORT DATE: 23-25 September 1980
13. NUMBER OF PAGES: 18

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): 12 22
15. SECURITY CLASS. (of this report): UNCLASSIFIED
15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT (of this Report)
Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
Mercator computation
Great Circle computation
DEG.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Navigation Department, Defense Mapping Agency Hydrographic/Topographic Center (DMAHTC) has developed a calculator program, self-contained on one magnetic card, which automatically determines course, distance, and total run in Mercator and Great Circle Sailings. This program will list Great Circle positions every 10° of longitude and then print course and distance for each leg. Labels designating latitudes and longitudes, and program sections are also shown. The entire program is controlled by six label keys and can be shifted over

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. ABSTRACT (continued)

between Mercator and Great Circle at will. It is prepared on a programmable TI-59 with Marine Navigation Module software and printer capability. The program is in use at DMAHTC for compiling distance tables, and navigational publications and answering public inquiries.

The following data are incorporated in this article: General Information, Mercator Computation, Great Circle Computation, Great Circle Positions Great Circle Course Computation, Program Data, and Special Considerations.

A CALCULATOR PROGRAM FOR MIXING MERCATOR AND GREAT CIRCLE SAILINGS

John G. Ulrich
Sailing Directions Branch
Defense Mapping Agency Hydrographic/Topographic Center

Submitted to
First International Symposium on Ship Operations

New York City, New York
23-25 September 1980

A CALCULATOR PROGRAM FOR MIXING MERCATOR AND GREAT CIRCLE SAILINGS

John G. Ulrich
Defense Mapping Agency Hydrographic/Topographic Center

BIOGRAPHICAL SKETCH

The author graduated from Kings Point in 1951, sailed as 2nd and 3rd Mate from 1951 to 1955, and served in the U.S. Navy as navigator from 1955 to 1957. He was employed by the U.S. Naval Oceanographic Office from 1964 to 1972, the Defense Mapping Agency Hydrographic Center from 1972 to 1978, and presently is a Marine Information Specialist in the Navigation Publications Division, Defense Mapping Agency Hydrographic/Topographic Center.

ABSTRACT

The Navigation Department, Defense Mapping Agency Hydrographic/Topographic Center (DMAHTC) has developed a calculator program, self-contained on one magnetic card, which automatically determines course, distance, and total run in Mercator and Great Circle Sailings. This program will list Great Circle positions every 10° of longitude and then print course and distance of each leg. Labels designating latitudes and longitudes, and program sections are also shown. The entire program is controlled by six label keys and can be shifted between Mercator and Great Circle at will. It is prepared on a programmable TI-59 with Marine Navigation Module software and printer capability. The program is in use at DMAHTC for compiling distance tables, and navigational publications and answering public inquiries.

The following data are incorporated in this article: General Information, Mercator Computation, Great Circle Computation, Great Circle Positions, Great Circle Course Computation, Program Data, and Special Considerations.

A CALCULATOR PROGRAM FOR MIXING MERCATOR AND GREAT CIRCLE SAILINGS

Introduction

The program was developed in the Navigation Department of the Defense Mapping Agency Hydrographic/Topographic Center for computing distances and Great Circle tracks. It is suitable for programmable calculators with Marine Navigation Module software and printer capability, and will provide Mercator harbor and coastal courses and distances; Great Circle positions, courses, and distances; and total runs from dock to dock. It can be used for any individual sequence or with any combination of Mercator and Great Circle Sailings.

General Information

The overall program was designed on a TI-59 calculator* (See Fig. 1) with parts of Program 11 (Mercator) and Program 26 (Great Circle), either downloaded and adjusted, or ordered directly from the Marine Navigation Module. With it, the user has the convenience and accuracy of using the module without pressing numerous keys and without reloading repetitive positions. When using the module directly, operators have frequently reloaded such positions incorrectly and have also over-

*Any mention herein of a commercial product does not constitute endorsement by the U.S. Government.

run the calculator's computations before it was ready for additional information. With the designed program, after the initial entering of the first position, the calculator is controlled by one or two basic label keys per program section, making it considerably easier to call the correct sequence. All latitudes are parked on the T-register key and all longitudes are situated in the display before initiation of the Sailing sequence. There are 461 locations in the program. Initial programing requires about 1 hour; however, once on a magnetic card, loading requires only 10 to 15 seconds.

All positions are keyed: degrees, decimal (.), minutes, and seconds.

Thus, 39°02'N is 39.02

39°02'11"N is 39.0211

39°N is 39 (decimal inferred)

N and W are + (inferred)

S and E are - (+/-key)

Thus, 39.02 +/- displays as -39.02

Mercator

Label keys A' and A are used in the Mercator sequence. A' is used for initiation and only used once; all further positions go directly to A. The last position is repeated for continuity of the program; this is an automatic A' return. The Mercator sequence is normally run in degrees and minutes; seconds may be added if more accuracy is desired.

Example:

1st	40°42'N	2nd	40°33'N.
Posit	74°02'W	Posit	74°02'W.
3rd	40°30'N	4th	40°27'N.
Posit	73°58'W	Posit	73°43'W.

Key as follows:

1st	40.42	Press x ⇄ t
Posit	74.02 in display	Press 2nd A
	40.4200 LAT1	(PRINTED)
	74.0200 LO1	
2nd	40.33	Press x ⇄ t
Posit	74.02 in display	Press A
	40.3300 LAT2	
	74.0200 LO2	
	180.00 CO	
	9.00 MI	(PRINTED)
	9.00 TOT	
	40.3300 LAT1	
	74.0200 LO1	

3rd 40.30 Press x ≠ t

Posit 73.58 in display Press A

40.3000 LAT2

73.5800 LO2

134.62 CO (PRINTED)

4.27 MI

13.27 TOT

40.3000 LAT1

73.5800 LO1

4th 40.27 Press x ≠ t

Posit 73.43 in display Press A

40.2700 LAT2

73.4300 LO2

104.73 CO

11.80 MI (PRINTED)

25.07 TOT

40.2700 LAT1

73.4300 LO1

Course and distance are therefore given for each leg and total distance is maintained throughout.

Full Printout of Mercator Example

```
 40.4200   LAT1
 74.0200   LO1
 40.3300   LAT2
 74.0200   LO2

180.00     CO
  9.00     MI
  9.00     TOT

 40.3300   LAT1
 74.0200   LO1
 40.3000   LAT2
 73.5800   LO2

134.62     CO
  4.27     MI
 13.27     TOT


 40.3000   LAT1
 73.5800   LO1
 40.2700   LAT2
 73.4300   LO2

104.73     CO
 11.80     MI
 25.07     TOT

 40.2200   LAT1
 73.4300   LO1
```

Great Circle

Label keys C and C' control the Great Circle sequence; C is used for the initial departure; C' is used for the arrival position. The last position of the Mercator sequence is auto-

matically entered if the user wishes. All Great Circle positions are run in the four-digit mode but still entered in the two-digit degree, decimal (.),minute mode.

Example: New York to Capetown (See Fig. 2)

Dep: 40°27'N Arr: 33°51'S

73°43'W 18°15'E

40.2700 Still in

73.4300 calculator memory

Press C

GRT CIRCLE

4027.00 (PRINTED)

7343.00

Arr: -33.51 Press x ⇄ t

-18.15 in display Press 2nd C

-3351.00

-1815.00

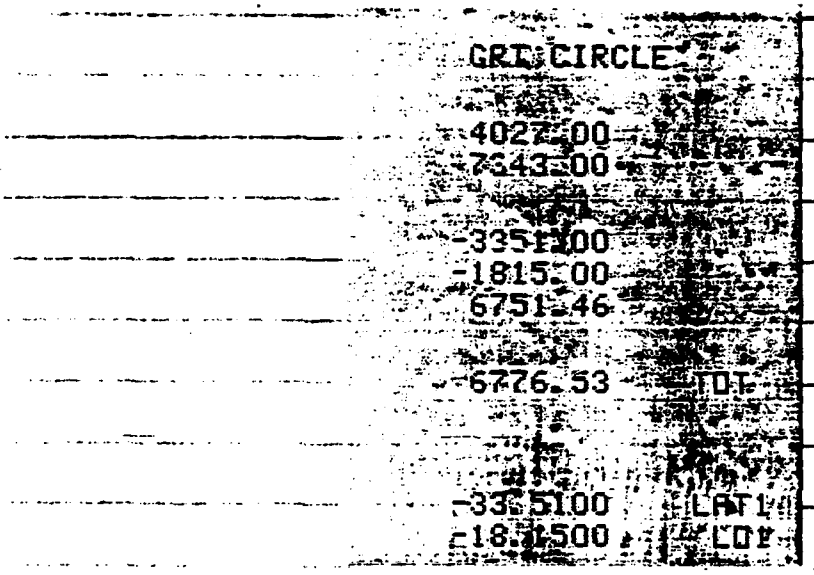
6751.46 (PRINTED)

6776.53 TOT

-33.5100 LAT1

-18.1500 LO1

Full Printout of Great Circle Example



The figure immediately below the arrival position is the Great Circle distance; the total is the Great Circle distance added to the total of any preceding Mercator distances.

At this point the user may either return to Mercator to his final destination, to another Great Circle, or he may call for the positions on the above Great Circle example.

Great Circle Positions

All Great Circle positions are run in even 10° of longitude in the direction the user wishes to proceed. The normal sequence is 6 positions but by pressing SBR twice, the number of Great Circle positions may be increased to 13. This may be done before doing the initial Great Circle work and will show in the display at the end of the Great Circle sequence.

If the user has not initiated the 13-position sequence before running the Great Circle, he may do so afterwards, but before running the Great Circle positions. The number 13 will again show in the display.

The initial Great Circle position was:

40°27'N. 73°43'W.

Enter even longitude divisable by 10, the next such meridian in direction of arrival. This must show in the display. No decimal is required.

Thus: 70 in display Press E

GRT CIRCLE POS
7000.0000
3858.7344
6000.0000
3403.6856
5000.0000
2735.0067
4000.0000
1926.2700
3000.0000
947.7389
2000.0000
-44.1478

```
 1000.0000
-1111.7944

    0.0000
-2039.4789

-1000.0000
-2834.5289

-2000.0000
-3449.6789

-3000.0000
-3932.7567

-4000.0000
-4256.3633

-5000.0000
-4512.1978


  -33.5100    LAT1
  -18.1500    LO1
```

The last ~~three~~ four positions are beyond the arrival position but still part of the same Great Circle. As can be seen, the longitude is on top and the latitude on the bottom. The four decimal places are for accuracy; all numbers to the right of the decimal are decimal minute. Therefore, 3858.7344 is read as 38°58.73'N.

Great Circle Courses

The calculator will recall each of the Great Circle positions and automatically print out the Mercator course and distance for each leg. The total distance is reset to 0 for these calculations and not added to the original totals. These courses are called by D' (2nd D). No other input is required.

Press 2nd D

Partial Run of Great Circle Courses

GRT CIRCLE CO	
40.2700	LAT1
73.4300	LO1
38.5844	LAT2
70.0000	LO2
117.23	CO
192.91	MI
192.91	TOT
38.5844	LAT1
70.0000	LO1
34.0341	LAT2
60.0000	LO2
121.48	CO
565.03	MI
757.94	TOT

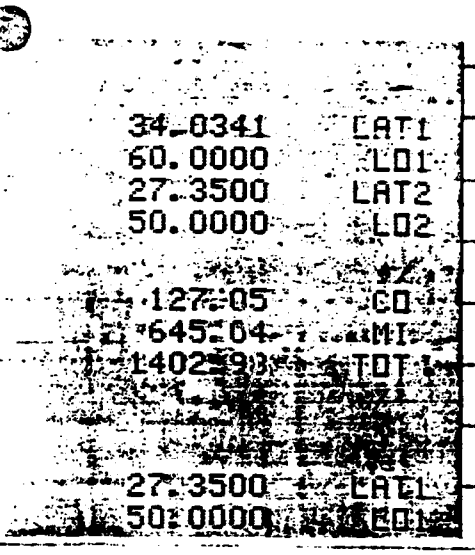


Fig. 1. A Programmable Calculator

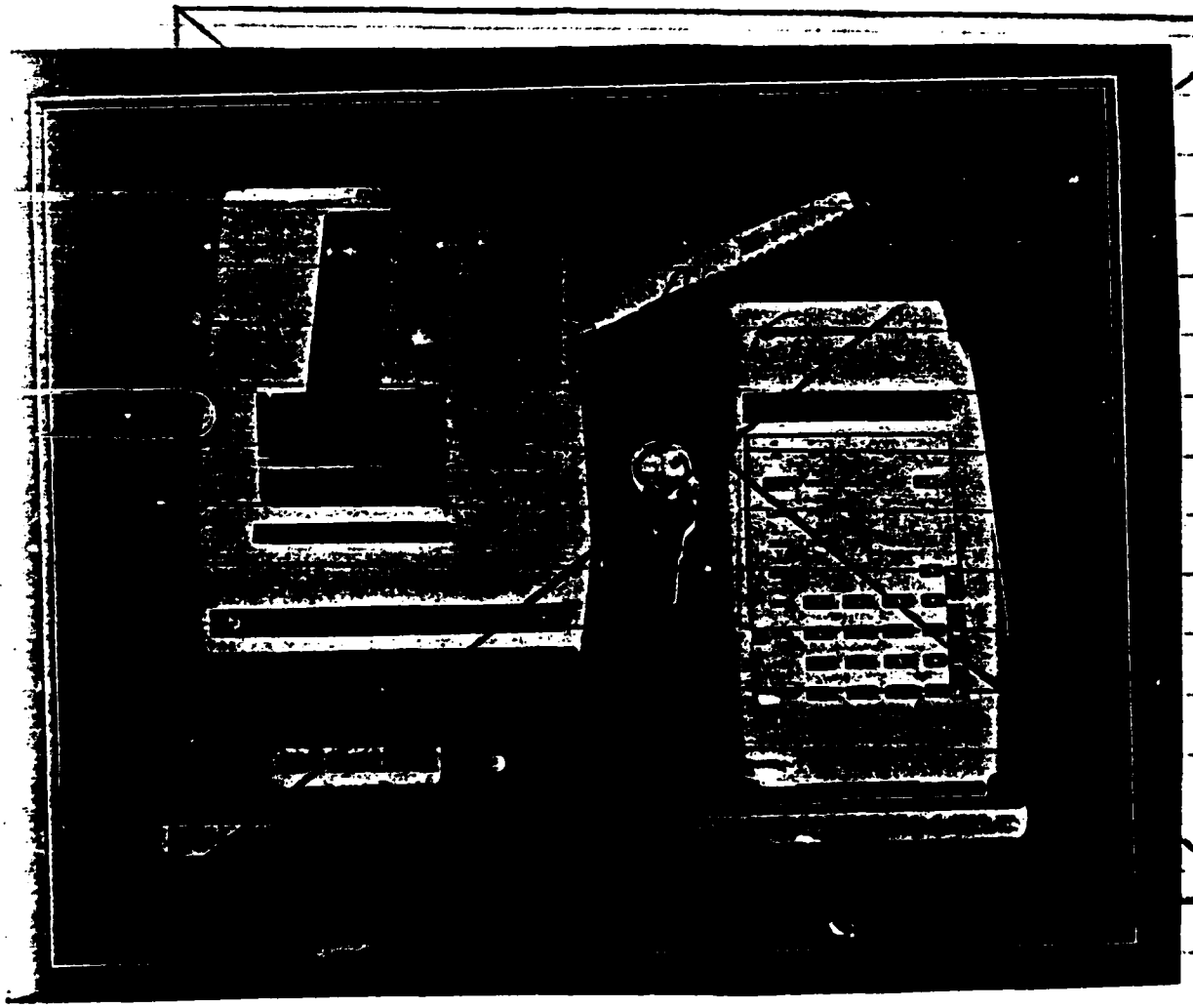
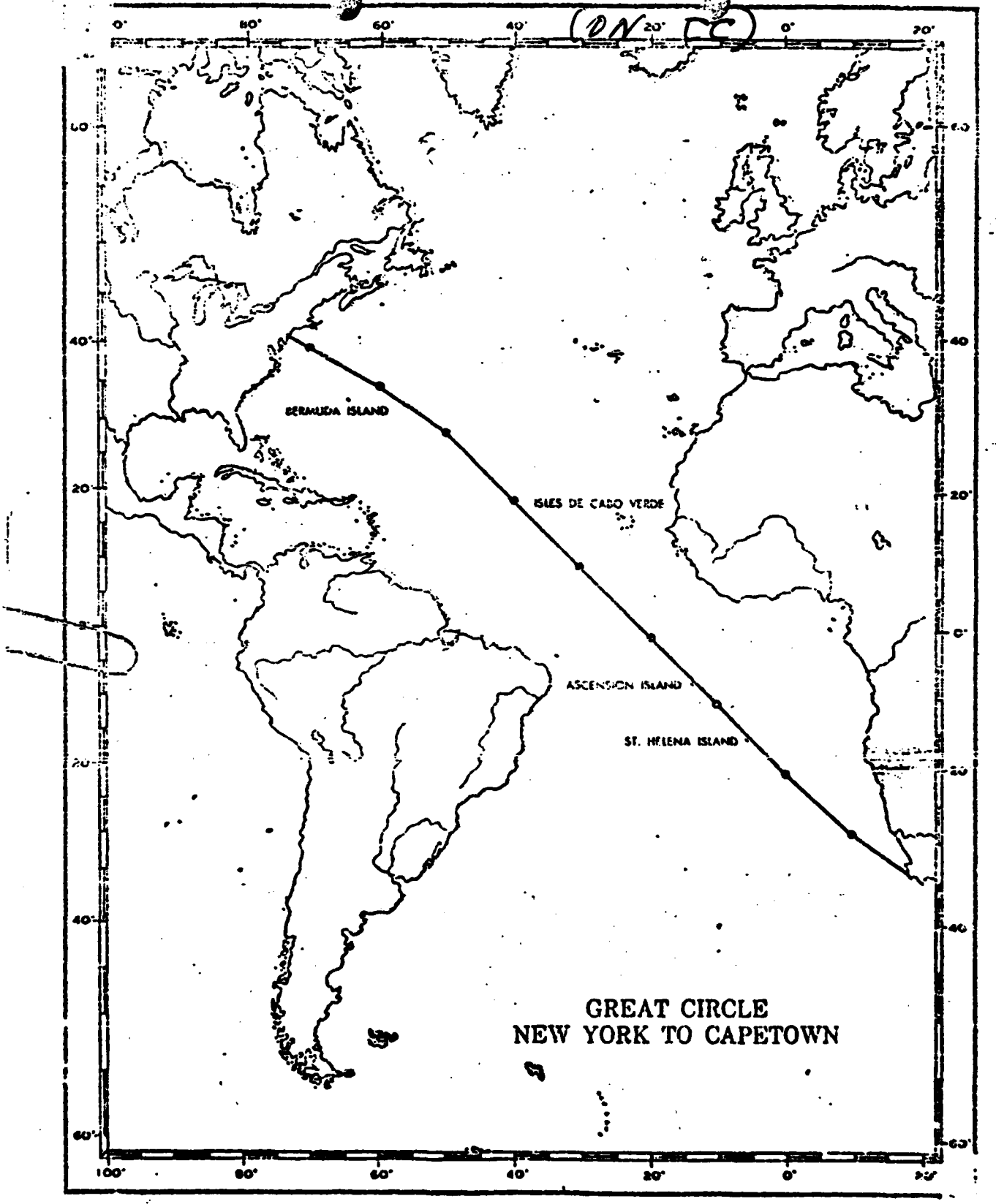


FIG 2 CHART OF GREAT CIRCLE TRACK



G.E. Hynson

2EABB DSEJ

Fig. 2. Chart of Great Circle Track

Program Data

000	76	LBL	045	69	OP	090	02	02
001	16	A'	046	06	06	091	43	RCL
002	98	ADV	047	22	INV	092	18	18
003	98	ADV	048	58	FIX	093	22	INV
004	32	X:T	049	92	RTN	094	77	GE
005	22	INV	050	76	LBL	095	17	B'
006	58	FIX	051	11	A	096	61	GTO
007	42	STO	052	32	X:T	097	01	01
008	04	04	053	42	STO	098	07	07
009	88	DMS	054	04	04	099	92	RTN
010	42	STO	055	42	STO	100	76	LBL
011	02	02	056	24	24	101	17	B'
012	02	2	057	88	DMS	102	85	+
013	02	7	058	42	STO	103	03	3
014	01	1	059	21	21	104	06	6
015	03	3	060	02	2	105	00	0
016	03	3	061	07	7	106	95	=
017	07	7	062	01	1	107	98	ADV
018	00	0	063	03	3	108	42	STO
019	02	2	064	03	3	109	18	18
020	71	SBR	065	07	7	110	01	1
021	52	EE	066	00	0	111	05	5
022	32	X:T	067	03	3	112	03	3
023	42	STO	068	71	SBR	113	02	2
024	04	04	069	52	EE	114	69	OP
025	88	DMS	070	32	X:T	115	04	04
026	42	STO	071	42	STO	116	43	RCL
027	03	03	072	04	04	117	18	18
028	02	2	073	42	STO	118	69	OP
029	07	7	074	25	25	119	06	06
030	03	3	075	88	DMS	120	03	3
031	02	2	076	42	STO	121	00	0
032	00	0	077	22	22	122	02	2
033	02	2	078	02	2	123	04	4
034	71	SBR	079	07	7	124	69	OP
035	52	EE	080	03	3	125	04	04
036	92	RTN	081	02	2	126	43	RCL
037	76	LBL	082	00	0	127	15	15
038	52	EE	083	03	3	128	69	OP
039	69	OP	084	71	SBR	129	06	06
040	04	04	085	52	EE	130	71	SBR
041	43	RCL	086	36	PGM	131	68	NOP
042	04	04	087	11	11	132	43	RCL
043	58	FIX	088	13	C	133	24	24
044	04	04	089	58	FIX	134	32	X:T

Bottom of running head and page...

Program Data

135	43	RCL	180	26	26	225	36	PGM
136	25	25	181	12	B	226	26	26
137	61	GTO	182	92	RTN	227	14	D
138	16	A'	183	76	LBL	228	71	SBR
139	76	LBL	184	43	RCL	229	68	NOP
140	68	NOP	185	69	OP	230	10	E'
141	44	SUM	186	00	00	231	76	LBL
142	27	27	187	02	2	232	14	D
143	03	3	188	02	2	233	03	3
144	07	7	189	03	3	234	01	1
145	03	3	190	05	5	235	42	STO
146	02	2	191	03	3	236	17	17
147	03	3	192	07	7	237	04	4
148	07	7	193	00	0	238	05	5
149	69	OP	194	00	0	239	42	STO
150	04	04	195	01	1	240	23	23
151	43	RCL	196	05	5	241	02	2
152	27	27	197	69	OP	242	42	STO
153	69	OP	198	02	02	243	08	08
154	06	06	199	02	2	244	01	1
155	92	RTN	200	04	4	245	04	4
156	76	LBL	201	03	3	246	42	STO
157	13	C	202	05	5	247	09	09
158	98	ADV	203	01	1	248	87	IFF
159	98	ADV	204	05	5	249	01	01
160	42	STO	205	02	2	250	02	02
161	45	45	206	07	7	251	55	55
162	32	X:T	207	01	1	252	07	7
163	42	STO	208	07	7	253	42	STO
164	31	31	209	69	OP	254	09	09
165	32	X:T	210	03	03	255	75	-
166	71	SBR	211	92	RTN	256	01	1
167	43	RCL	212	76	LBL	257	95	=
168	69	OP	213	18	C'	258	92	RTN
169	05	05	214	42	STO	259	76	LBL
170	58	FIX	215	29	29	260	12	B
171	02	02	216	32	X:T	261	32	X:T
172	43	RCL	217	42	STO	262	65	×
173	45	45	218	30	30	263	01	1
174	12	B	219	32	X:T	264	00	0
175	36	PGM	220	12	B	265	00	0
176	26	26	221	36	PGM	266	95	=
177	11	A	222	26	26	267	88	DMS
178	12	B	223	13	C	268	92	RTN
179	36	PGM	224	12	B	269	76	LBL

Program Data

270	15	E	315	69	OP	360	95	=			
271	42	STO	316	05	05	361	32	X:T			
272	12	12	317	58	FIX	362	01	1			
273	97	DSZ	318	04	04	363	08	8			
274	09	09	319	98	ADV	364	00	0			
275	02	02	320	43	RCL	365	67	EQ			
276	82	82	321	12	12	366	03	03			
277	87	IFF	322	72	ST*	367	75	-			
278	02	02	323	23	23	368	94	+/-			
279	19	D*	324	32	X:T	369	67	EQ			
280	61	GTO	325	12	B	370	03	03			
281	10	E'	326	36	PGM	371	75	-			
282	01	1	327	26	26	372	32	X:T			
283	44	SUM	328	15	E	373	61	GTO			
284	17	17	329	22	INV	374	15	E			
285	01	1	330	88	DMS	375	86	STF			
286	44	SUM	331	55	÷	376	04	04			
287	23	23	332	01	1	377	32	X:T			
288	97	DSZ	333	00	0	378	94	+/-			
289	08	08	334	00	0	379	61	GTO			
290	02	02	335	95	=	380	15	E			
291	95	95	336	72	ST*	381	76	LBL			
292	61	GTO	337	17	17	382	10	E'			
293	03	03	338	43	RCL	383	43	RCL			
294	20	20	339	01	01	384	30	30			
295	22	INV	340	32	X:T	385	32	X:T			
296	86	STF	341	43	RCL	386	43	RCL			
297	04	04	342	12	12	387	29	29			
298	22	INV	343	77	GE	388	61	GTO			
299	86	STF	344	03	03	389	16	A'			
300	03	03	345	52	52	390	76	LBL			
301	98	ADV	346	87	IFF	391	19	D'			
302	98	ADV	347	04	04	392	98	ADV			
303	58	FIX	348	03	03	393	98	ADV			
304	02	02	349	52	52	394	14	D			
305	71	SBR	350	86	STF	395	58	FIX			
306	43	RCL	351	03	03	396	04	04			
307	03	3	352	75	-	397	71	SBR			
308	03	3	353	01	1	398	43	RCL			
309	03	3	354	00	0	399	01	1			
310	02	2	355	87	IFF	400	05	5			
311	03	3	356	03	03	401	03	3			
312	06	6	357	03	03	402	02	2			
313	69	OP	358	60	60	403	69	OP			
314	04	04	359	94	+/-	404	04	04			

Program Data

405	69	DP	424	61	GTO	443	10	E'
406	05	05	425	04	04	444	92	RTN
407	43	RCL	426	29	29	445	76	LBL
408	27	27	427	71	SBR	446	44	SUM
409	42	STO	428	44	SUM	447	61	GTO
410	28	28	429	01	1	448	00	00
411	00	0	430	44	SUM	449	03	03
412	42	STO	431	17	17	450	92	RTN
413	27	27	432	01	1	451	76	LBL
414	73	RC*	433	44	SUM	452	71	SBR
415	17	17	434	23	23	453	86	STF
416	32	X:T	435	97	DSZ	454	01	01
417	73	RC*	436	09	09	455	14	D
418	23	23	437	04	04	456	92	RTN
419	97	DSZ	438	14	14	457	76	LBL
420	08	08	439	43	RCL	458	61	GTO
421	04	04	440	28	28	459	86	STF
422	27	27	441	42	STO	460	02	02
423	11	A	442	27	27	461	92	RTN

Special Considerations

1. The run-stop (R/S) key will stop the program if held down for a few seconds.

2. Fifty-four memories are used in the program. The memories used for the totals (TOT) are memory 27 and memory 28. If an incorrect position is entered on A or C' the R/S key should be pressed before the computations are run to save the total memory. The calculator can then be restarted as necessary at A or C'.

3. The Great Circle positions (GCP's) run on Label E are based on the Great Circle memories and, when required, should be run immediately after the Great Circle sequence.

4. Label D may be pressed at any time between sequences to check the number of GCP's calculator is set to run.

5. If an incorrect longitude is entered on E, press R/S until program stops, then press D, enter the correct longitude, and press E.

6. The automatic sequence of Mercator for the Great Circle courses may be made to automatically follow the GCP's by pressing SBR GTO before pressing E. The user may then disregard the calculator for several minutes.

7. The GCP's run on E will cross the 180° meridian with no adjustment, provided 180 is printed in the sequence.

8. The normal six (6) GCP run can be reset at location 252 to any number between 2 and 9.

9. The 10° differential on the GCP run can be reset at location 353. It must be in a two digit form such as 05, 10, or 20.

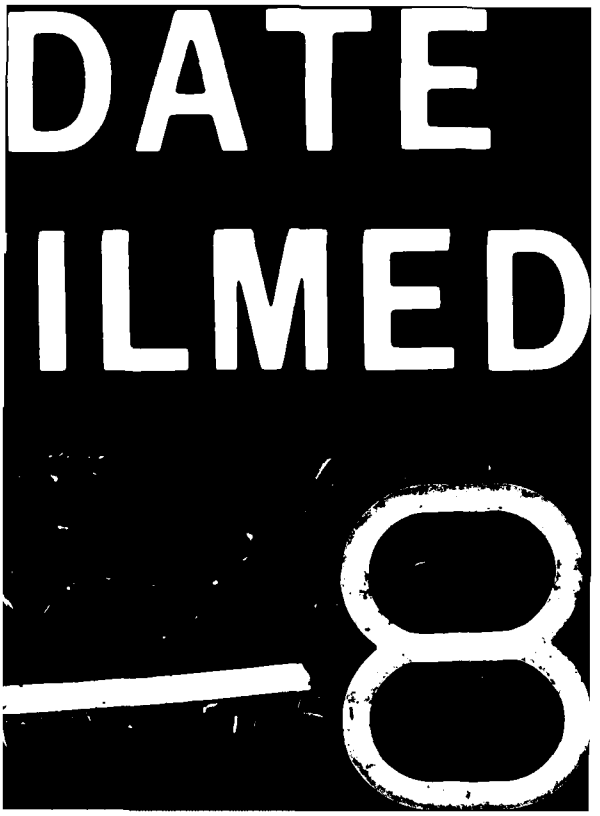
10. If the user wishes to stop the program run on E (GCP's), E' (2nd E) will recall the last position for re-entering to Great Circle or Mercator. This is not necessary if the GCP's are run to completion.

11. When sequencing Great Circles, it is necessary to recall the last position (arrival) for the new departure. As above, press E' then C, etc.

12. If a full run on D' (GC CO's) is not anticipated, run D' last, after the final Mercator runs, so as not to lose the primary total memory. If all GC courses are run the memories will automatically transfer.

13. When the user intends to start an entirely new Mercator and/or Great Circle sequence, without reloading, the CM's key should be pressed to clear the total memories.

14. The program automatically changes decimal minutes in the Great Circle sequences to seconds of arc in the Mercator sequence, and seconds to decimal minutes in the reverse.


DATE
ILMED
8